Cooperative Agriculture Pest Survey program

2004 Survey Annual Report

Phytophthora ramorum
2004
National
Nursery Survey

United States Department of Agriculture

Animal and Plant Health Inspection Service
Plant Protection and Quarantine

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Table of Contents

INTRODUCTION and BACKGROUND

Phytophthora ramorum, the causal agent of sudden oak death, ramorum blight, and ramorum canker, is known to occur in coastal forests, some horticultural nurseries in the western United States, and in nurseries and landscape plantings in Europe. *Phytophthora ramorum* is one of a number of organisms (although not true fungi) that are collectively called "water molds." Phytophthora is translated to "Plant Destroyer" and most of the *Phytophthora* species are plant pathogens, many with extremely large host ranges.

Regulations were published February 14, 2002, to control the movement of sudden oak death from ten infested counties (now 14) in California and an area under eradication in Oregon. Research being conducted by the Agriculture Research Service, US Forest Service, Universities and others is under way to better identify hosts, methods of detection, and effective treatments. Currently, 68 plants are regulated, two of which at the genus level (Camellia and Rhododendron). In April 2004, a Federal Order was issued to prevent *P. ramorum* moving via nursery stock from California. APHIS issued a revised order in December 2004 that extended the regulation to the states of Oregon and Washington.

In 2004, several large nurseries shipped more than 2 million potentially infested Camellias, rhododendron and other nursery stock to 40 states. A total of 171 nurseries and retail garden centers in 20 states were determined to be infested with Pr. Fifteen of these 171 sites were found during the 2004 National Survey. The positive nurseries underwent the APHIS confirmed nursery protocol to eradicate the pest. The breakdown per State is: AL (3), AR (1), AZ (1), CA (55), CO (1), CT (3), FL (6), GA (14), LA (5), MD (3), NC (9), NJ (1), NM (1), OK (1), OR (24), SC (3), TN (2), TX (11), VA (2) and WA (25).

THE NATIONAL NURSERY SURVEY PROGRAM

The 2004 *Phytophthora ramorum* National Nursery Survey was a national survey designed to gather information on the distribution of the disease known as sudden oak death, ramorum blight and ramorum die-back caused by the pathogen, *Phytophthora ramorum*. The National Survey efforts were concentrated in two areas, forests (coordinated by USDA Forest Service) and in nurseries (coordinated by USDA Animal and Plant Health Inspection Service – Plant Protection and Quarantine). This document reports on the findings of the APHIS 2004 *Phytophthora ramorum* National Nursery Survey Program.

The national nursery survey design reflected our experience with this disease on the west coast of the United States and available information on the European experience at the start of 2004. We designed the survey plan using information gathered during 2002 and 2003 pilot surveys. Host lists and symptomology were based on what had observed on the west coast and in Europe through that time.

Federal funds were offered to all states to support the 2004 survey.

This 2004 national nursery survey was coordinated nationally by:

- Daniel J. Williams, Assistant to the National Survey Coordinator and Program Manager for the National *P. ramorum* Nursery Survey
- Donald Givens, Program Manager in the Western Regional Office
- Lloyd Garcia, Program Manager in the Eastern Region Office
- Jonathan Jones, National *P. ramorum* Program Manager

State cooperators who participated in the national P. ramorum survey for 2004 were asked to identify high risk nursery sites for *P. ramorum* inspections based on a set of high risk parameters set out in the National SOD Survey Manual. The national survey was funded under the CAPS umbrella was distributed to 49 states through the standard USDA CAPS Cooperative Agreement and designated *P. ramorum* work plan.

THE 2004 SURVEY METHOD

The 2004 Phytophthora ramorum National Nursery Survey methods are contained in Appendix 1. They are summarized here.

Following the detections of *P. ramorum* at two large Southern California nurseries in early March 2004, APHIS became significantly more the concerned about the potential for the pathogen to move in and be harbored by nursery stock. In order to address these concerns APHIS deemed necessary the systematic surveys of nurseries and their environs throughout the United States.

Inspectors selected the times and places for survey based on several factors including climate, available host material and overall risk associated with their state and risk by type of nursery facility. Inspectors were directed to time inspections to begin as favorable climate conditions for this pathogen begin to develop in their state. Having selected a start date, the surveyors used APHIS Climate Match Maps and the table below to determine, how many and where sites with nurseries need to be inspected based on risk:

- If a state was wholly or in part listed in Risk **Group I**, a minimum of **25 sites** in that state were to be inspected (**high risk**).
- If a state was in wholly or in part listed in Risk **Group II**, a minimum of **20 sites** in that state were to be inspected (**moderate risk**).
- If a state was in wholly or in part listed in Risk **Group III**, a minimum of **15 sites** in that state were to be inspected (**low risk**).

Once the number of nurseries to be inspected was selected, surveyors determined how many establishments of each type should be visited using Table 1.

Table 1. Selecting Nurseries Based on Composite of Risk Factors

Inspect those with highest Rating First!!	1 Facility Type	2 Known Pathway	3 Native Hosts	4 Hosts in Inventory	TOTAL Rating	Example
Production nurseries	1	1	1	1	4	Highest
Wholesale nurseries	1	1	0	1	3	
Tree farms/plantations	1	0	1	1	3	
Retail nurseries	1	0	0	1	2	
Retail outlets	1	0	0	0	1	Lowest
(1= Yes, 0 = No)						

Inspectors were directed to select a representative mix of nursery types to visit. Nurseries containing host and associated host plants, that received known host plant materials from Europe (especially the Netherlands) and infested areas in California, Oregon, Washington State and British Columbia, and nurseries located in areas where native vegetation includes hosts of *P. ramorum* were given priority.

Through visual inspection, surveyors determined the general condition of host plants and performed a more rigorous visual inspection of a minimum of 100 plants or at least 2% at random of each host genus present. From this visual examination, they selected a minimum of 40 samples with symptoms. If no symptoms were observed, the inspectors noted how many hosts were inspected and that none had exhibited symptoms. They also located and inspected cull piles of plant materials that have been taken off site or discarded and native host vegetation growing along the perimeter of the nurseries; collecting additional samples if symptomatic material was observed. In general, if *P. ramorum* symptoms were detected, inspectors were required to take samples for laboratory confirmation.

Samples were submitted to state department of agriculture laboratories, National Plant Diagnostic Laboratories or a commercial laboratory for testing. APHIS encouraged these labs to screen samples using an APHIS-approved ELISA method prior to culturing or doing a Polymerase Chain Reacton (PCR) test. A negative ELISA indicated that the sample was free of *Phytophthora* species and ended the testing process. Positive ELISAs needed to be confirmed by PCR or culture. Cultures not positive for *P. ramorum* needed to be confirmed as not positive for *P. ramorum* by nested-PCR. If a lab did not conduct ELISA testing or if the ELISA was positive, or if a negative culture was determined to be not positive for *P. ramorum*, State, university and commercial labs were directed to extract DNA from the sample. The extracted DNA was sent to the APHIS National Plant Germplasm and Biotechnology Laboratory. There the presence or absence of *P. ramorum* was confirmed by nested PCR. Some states may have made negative determinations based on PCR or culturing conducted in their labs.

Survey results were entered in the NAPIS database. Under the CAPS agreement with APHIS and the survey work plan the cooperators agreed to:

- submit survey data collected under the CAPS umbrella directly to NAPIS.
- submit survey data with 14 days after it is collected, verified and reviewed by state
- submit new state and national pest survey data with in 48 hrs of Confirmation

RESULTS

As of March 22, 2005, 49 of 50 states reported participation in the 2004 *Phytophthora ramorum* National Nursery Survey to NAPIS. In these states there were 57,391 nurseries in 1726 counties eligible for survey. Surveyors visited nurseries in 428 of these counties (24.8%); of these, 5 were reported as positive in the NAPIS database. Inspectors submitted 36,137 samples; 457 (1.3%) were reported as positive in the NAPIS database.

Data entered into the NAPIS database are summarized in Table 2. The NAPIS Database received National SOD survey records for only 26 (highlighted in bold type) of the 49 states participating in the project this year by December 3, 2004, as required by the cooperative agreements. The remaining states did not complete entering their records until March 22, 2005.

It was not possible to accurately and completely derive a count of individual nurseries surveyed from the 2004 data. The main reason for this was that some states used identifiers that did not follow the NAPIS data structure. An, even within states, there was occasional variations in the coding schemes used to identify survey sites.

APHIS also collected data from the states as part of its P. ramorum emergency program in 2004 (Table 3). Based on these data, states surveyed 3,130 nurseries (5.5% of the 57,391 potential nurseries). These data show 15 nursery sites found positive as part of national survey activities. The positive sites were in California, Oregon, Washington, Oklahoma, Maryland, New Jersey, and Virginia.

Figure 1 presents a breakdown of the 36,137 samples states submitted for laboratory testing in 2004. The total number of samples processed may include those collected for other surveys in 2004. In 2005 the NAPIS system will be able receive and distinguish between all SOD field records (trace forward/backward, delimiting, as well as national survey inspection activities). A total of 458 (1.3 %) of the samples submitted were found positive for *P. ramorum*. These positive reports came from eight states, CA (301), OR (54), GA (51), WA (45), LA (3), MD, (1) VA (1), OK (1) and NJ (1). The pathogen was found in 14% of the samples from CA, 1.3% from OR, 3.2% from GA, and 5% of those submitted by WA. It appears the positive reports from these states may include both confirmed and presumptive positive samples and/or multiple positives per nursery site.

Figures 2a and 2b graphically summarize the penetration of the survey by showing the number of counties in each state, the number of those counties where a nursery was inspected and the number of positive reported by the state in NAPIS. These positive were not consistently reported in the APHIS data as national survey samples and some may represent more than one sample per positive facility.

In 2004, inspectors surveyed 5,040,127 plants in 170 genera. *Rhododendron, Camellia, Viburnum, Quercus, Rosa, Abies, Pieris, Syringa,* and *Leucothoe* were the top genera surveyed and accounted for 4,768,783 of the plants inspected (94.6%). All of these genera are represented on the APHIS list of host and associated host plants and several are representative of the leading plant genera found positive in 2004. Genus data are summarized in tables 4a and 4b.

Table 2. NAPIS Database, Final Report for 2004 – Counties Where a Nursery was Reported Inspected

Count	States Participating	Counties per State*	Counties Inspected per State	Percent of Counties Inspected per State	Count	States Participating	Counties per State*	Counties Inspected per State	Percent of Counties Inspected per State
1	Alabama	67	22	32.8%	26	Montana	57	9	15.8%
2	Alaska	27	2	7.4%	27	Nebraska	93	14	15.1%
3	**Arizona**	**15**	**5**	**33.3%**	28	Nevada	17	8	47.1%
4	**Arkansas**	**75**	**22**	**29.3%**	29	New Hampshire	10	5	50.0%
5	California	58	48	82.8%	**30**	**New Jersey**	**21**	**13**	**61.9%**
6	Colorado	64	21	32.8%	31	New Mexico	33	7	21.2%
7	Connecticut	8	8	75.0%	**32**	**New York**	**62**	**15**	**24.2%**
8	**Delaware**	**3**	**3**	**100.0%**	**33**	**North Carolina**	**100**	**39**	**39.0%**
9	**Florida**	**67**	**26**	**38.8%**	34	North Dakota	53	10	18.9%
10	Georgia	159	28	17.6%	35	Ohio	88	11	12.5%
11	Hawaii**	NA	NA	NA	**36**	**Oklahoma**	**77**	**11**	**14.3%**
12	Idaho	44	27	61.4%	37	Oregon	36	29	80.6%
13	Illinois	102	23	22.5%	38	Pennsylvania	67	20	29.9%
14	**Indiana**	**92**	**20**	**21.7%**	**39**	**Rhode Island**	**5**	**5**	**100%**
15	**Iowa**	**99**	**14**	**14.1%**	40	South Carolina	46	20	43.5%
16	**Kansas**	**105**	**20**	**19.0%**	**41**	**South Dakota**	**67**	**13**	**19.4%**
17	**Kentucky**	**120**	**37**	**30.8%**	**42**	**Tennessee**	**95**	**20**	**21.1%**
18	**Louisiana**	**64**	**16**	**25.0%**	43	Texas	254	21	8.3%
19	**Maine**	**16**	**12**	**75.0%**	**44**	**Utah**	**29**	**10**	**34.5%**
20	**Maryland**	**24**	**15**	**62.5%**	45	Vermont	14	11	78.6%
21	**Massachusetts**	**14**	**11**	**78.6%**	**46**	**Virginia**	**136**	**17**	**12.5%**
22	Michigan	83	31	37.3%	**47**	**Washington**	**39**	**14**	**35.9%**
23	Minnesota	87	34	39.1%	**48**	**West Virginia**	**55**	**19**	**34.5%**
24	**Mississippi**	**82**	**17**	**20.1%**	**49**	**Wisconsin**	**72**	**12**	**16.7%**
25	**Missouri**	**115**	**13**	**11.3%**	**50**	**Wyoming**	**24**	**12**	**50.0%**
	* NASS source				**Number of Counties**		**1726**		
	** NA = not participating				**Total Number of Counties Inspected**			**428**	
	As of February 22, 2004				**Percent of Counties Reported as Inspected**				**24.8%**

States in bold did not report NAPIS data by the December 3, 2004 cutoff date.

Table 3. APHIS Situation Report, Final Report for 2004 - Nurseries Reported Inspected and Reported as 2004 National *P. ramorum* Nursery Survey Sites

Count	States Participating	Nurseries per State*	Nurseries Inspected per State*	Percent of Nurseries Inspected per State	Count	States Participating	Nurseries per State*	Nurseries Inspected per State	Percent of Nurseries Inspected per State
1	Alabama	799	34	4%	26	Montana	324	18	6%
2	Alaska	112	6	4%	27	Nebraska	357	20	6%
3	Arizona	375	15	2%	28	Nevada	51	50	98%
4	Arkansas	340	26	8%	29	New Hampshire	340	8	2%
5	California	4,570	88	2%	30	New Jersey	1,865	29	1%
6	Colorado	558	15	3%	31	New Mexico	237	26	11%
7	Connecticut	695	20	3%	32	New York	2,594	28	1%
8	Delaware	130	26	21%	33	North Carolina	2,618	100	4%
9	Florida	4,721	31	1%	34	North Dakota	78	17	22%
10	Georgia	1,213	20	2%	35	Ohio	2,700	21	1%
11	Hawaii**	1,425	NA	NA	36	Oklahoma	583	20	3%
12	Idaho	604	24	4%	37	Oregon	3,191	1210	38%
13	Illinois	1,116	34		38	Pennsylvania	3,120	28	1%
14	Indiana	1,123	20	3%	39	Rhode Island	226	48	18%
15	Iowa	567	20	7%	40	South Carolina	789	1	0.1%
16	Kansas	375	30	6%	41	South Dakota	123	5	18%
17	Kentucky	1,226	124	9%	42	Tennessee	2,350	22	1%
18	Louisiana	669	48	3%	43	Texas	2,161	38	2%
19	Maine	783	20	3%	44	Utah	286	19	7%
20	Maryland	788	29	2%	45	Vermont	432	20	5%
21	Massachusetts	910	76	5%	46	Virginia	1,266	28	2%
22	Michigan	2,225	39	2%	47	Washington	2,084	206	1%
23	Minnesota	1,004	67	7%	48	West Virginia	382	21	8%
24	Mississippi	405	27	7%	49	Wisconsin	1,505	33	2%
25	Missouri	946	25	3%	50	Wyoming	50	20	60%
	* NASS source				**Number U.S. Nurseries**		**57,391**		
	** NA = not participating				**Total Number Nurseries Inspected**			**3,130**	
	As of February 22, 2004				**Percent of Nurseries Reported as Inspected**				**5.%**

Figure 1a. National *P. ramorum* Nursery Lab Samples Reported Processed in 2004.

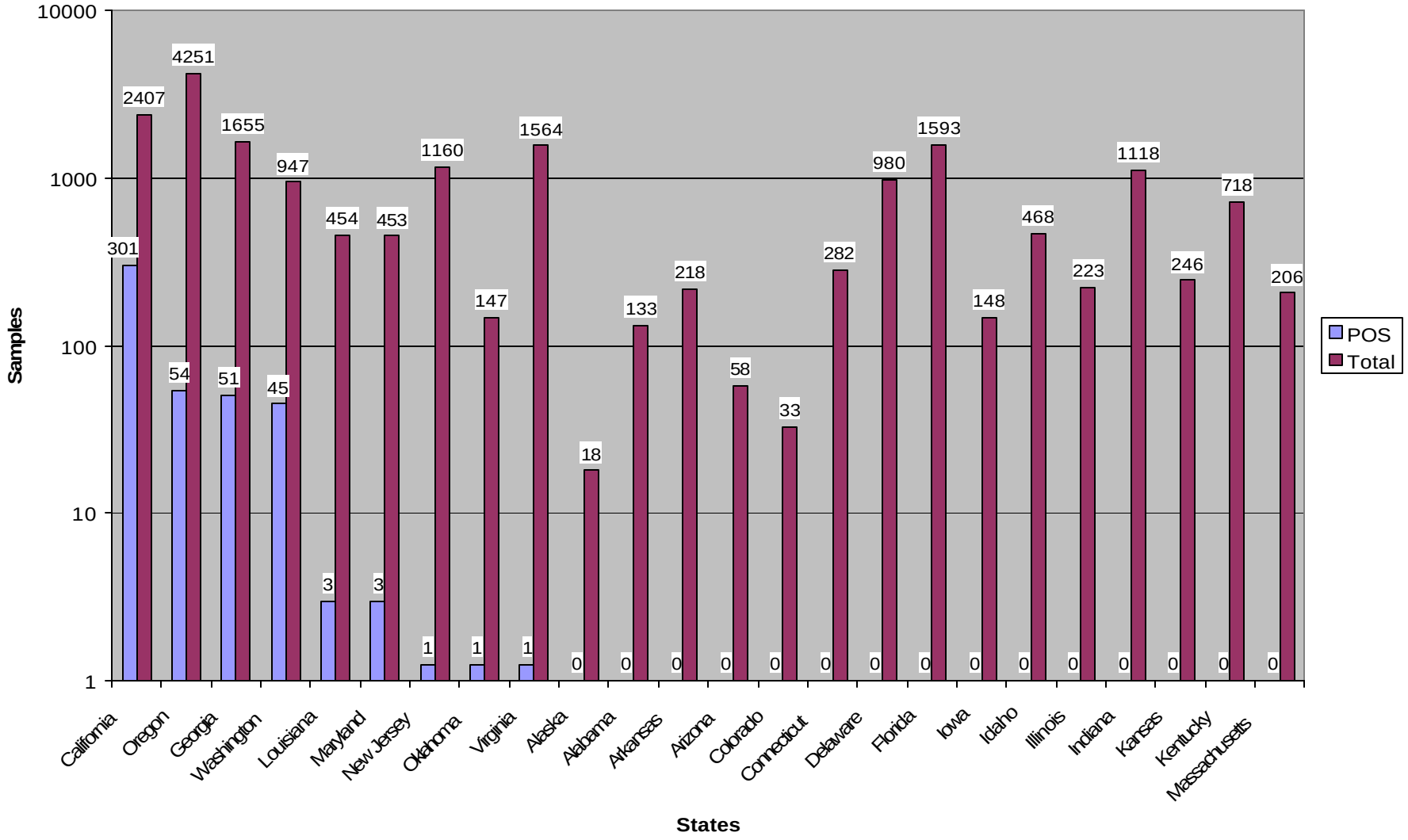

Figure 1b. National *P. ramorum* Nursery Lab Samples Reported Processed in 2004.

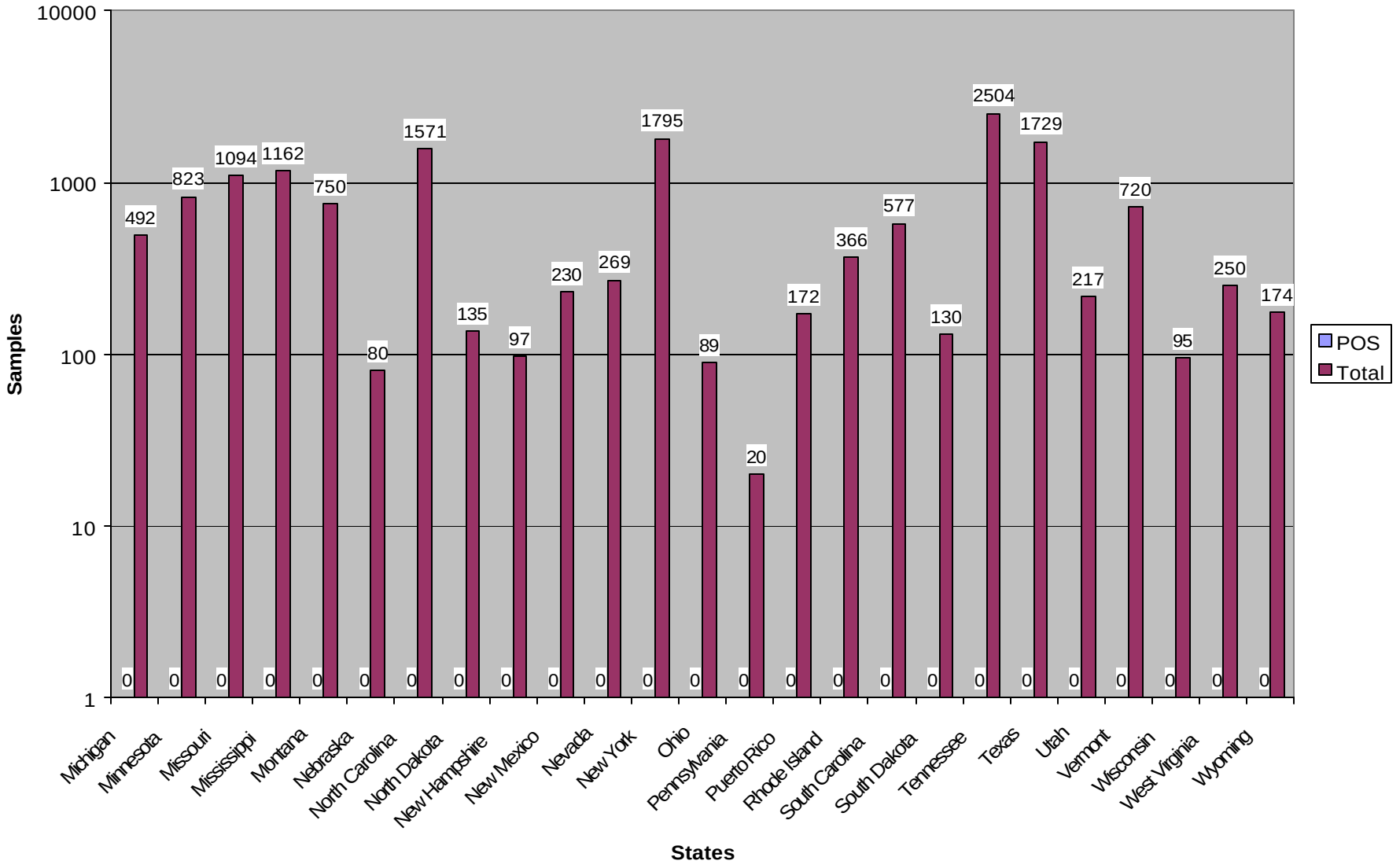

Figure 2a. Number of Counties per State, Number Counties Inspected, and Number of Counties with Positive Nurseries

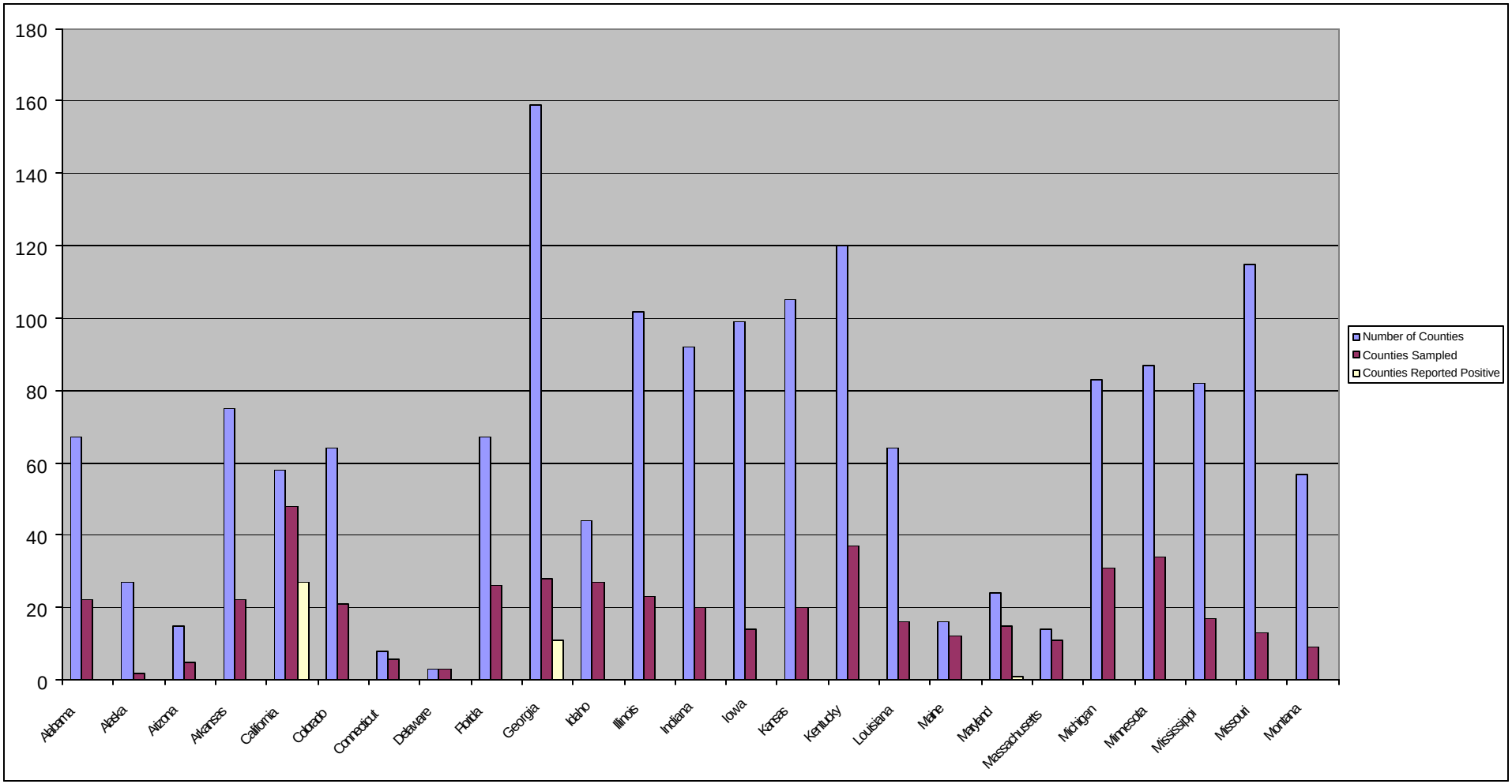

Figure 2b. Number of Counties per State, Number Counties Inspected, and Number of Counties with Positive Nurseries

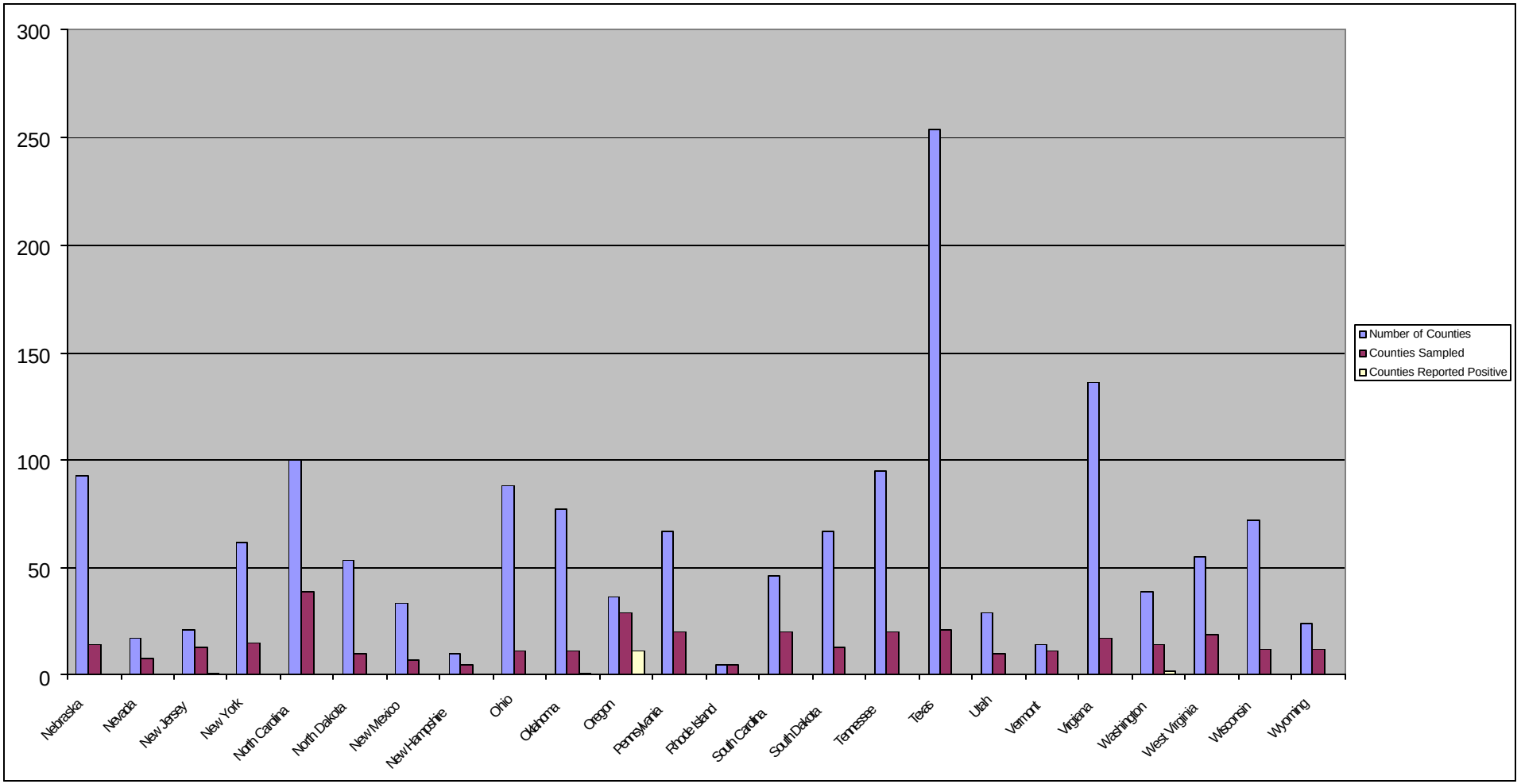

Table 4a. NAPIS Report – Host Plants Inspected for the 2004 National *P. ramorum* Nursery Survey: Top 99%

Hosts inspected during the 2004 The Top 99% of 170 of the Hosts inspected for Phytophthora ramorum in 2004. Those shaded in yellow are recognized as proven host and those in blue are plants associated with P. ramorum

No.	No. of Species. by Group	GENUS	No. Plants Inspected	Site visited	% of TTL
1	3+	RHODODENDRON-R	1,467,627	2956	29.1%
2	3+	CAMELLIA	974,988	933	19.3%
3	19+	VIBURNUM	974,832	2054	19.3%
4	4+	RHODODENDRON-A	370,880	1559	7.4%
5	18+	QUERCUS	318,338	959	6.3%
6	4	ROSA	276,839	508	5.5%
7	1	ABIES	186,908	1011	3.7%
8	3+	PIERIS	109,265	680	2.2%
9	4+	SYRINGA	50,316	825	1.0%
10	3+	LEUCOTHOE	38,790	249	0.8%
11	2+	PINUS	35,012	15	0.7%
12	4+	TAXUS	29,213	202	0.6%
13	2+	PYRACANTHA	20,225	175	0.4%
14	1+	PITTOSPORUM	17,491	58	0.3%
15	1+	ILEX	12,432	58	0.2%
16	1	LIRIODENDRON	11,545	3	0.2%
17	4+	HAMAMELIS	11,165	165	0.2%
18	3+	LONICERA	10,479	177	0.2%
19	1+	LIQUIDAMBAR	10,244	24	0.2%
20	1+	KALMIA	17,295	212	0.3%
21	4+	RHAMNUS	9,781	20	0.2%
22	+	SCHEFFLERA	9,488	2	0.2%
23	+	CROTON	9,487	1	0.2%
25	1	ULMUS	6,630	27	0.1%
26	1	PSEUDOTSUGA	5,511	126	0.1%
27	2+	BETULA	5,026	12	0.1%
28	4+	AESCULUS	5,663	132	0.1%
			4,995,470	13,143	

Table 4b. NAPIS Report – Host Plants Inspected for the 2004 National *P. ramorum* Nursery Survey: Remaining 1%

The last 1% of the hosts inspected represents 141 plant species containing 17 of the known or associated host species of *P. ramorum*.

Those shaded in yellow are recognized as proven hosts and those in blue are plants associated with *P. ramorum*.

No.	No. of Species	Host Names	Plants Inspected	% of Total
29	+	LIGUSTRUM	3,518	0.07
30	1	RAPHIOLEPIS	3,143	0.06
31	+	HYPERICUM	2,090	0.04
32	+	JASMINUM	1,973	0.04
33	2	ARBUTUS	1,953	0.04
34	1+	FAGUS	1,817	0.04
35	2+	MAGNOLIA	1,715	0.03
36	+	LIRIOPE	1,624	0.03
37	1	GINKGO	1,517	0.03
38	1	ARCTOSTAPHYLOS	1,268	0.03
39	1+	RUBUS	1,247	0.02
40	+	CORYLUS	1,223	0.02
41	+	MANDEVILLA	1,196	0.02
43	+	LANTANA	1,118	0.02
44	0	SALIX	988	0.02
45	1	CARYA	980	0.02
46	0	ILLICIUM	974	0.02
47	1	LAGERSTROEMIA	956	0.02
48	1	LOROPETALUM	827	0.02
49	1	METROSIDEROS	825	0.02
50	1	MYRICA	739	0.01
51	6	PRUNUS	725	0.01
52	0	COREOPSIS	690	0.01
53	1	VITEX	637	0.01
54	0	CLEMATIS	608	0.01
55	0	JUNIPERUS	574	0.01
56	1	ARAUCARIA	489	0.01
57	0	OSMANTHUS	480	0.01
58	1	WISTERIA	453	0.01
59	1	ARAUCARIA	444	0.01
60	1	BIGNONIA	444	0.01
61	0	ESCALLONIA	444	0.01
62	0	CERCIS	410	0.01
63	1	BUXUS	393	0.01
64	1	HIBISCUS	389	0.01
65	1	NANDINA	332	0.01
66	0	PYRUS	298	0.01
67	1	UMBELLULARIA	295	0.01
68	1	PLATANUS	294	0.01
69	0	ASPIDISTRA	284	0.01

No.	No. of Species	Host Names	Plants Inspected	% of Total
70	1	FEIJOA	284	0.01
71	12	HAMAMELIS	666	0.01
74	0	IXORA	203	0.00
75	1	JATROPHA	200	0.00
76	0	POPULUS	195	0.00
77	1	CASSIA	190	0.00
78	1	FOTHERGILLA	177	0.00
79	0	TIBOUCHINA	172	0.00
80	1	EUCALYPTUS	160	0.00
81	1	PROSOPIS	160	0.00
82	1	CORNUS	143	0.00
83	2	FAGUS	142	0.00
84	1	BRUNFELSIA	136	0.00
85	0	PASSIFLORA	135	0.00
86	1	CINNAMOMUM	100	0.00
87	1	MYRCIANTHES	100	0.00
88	1	WODYETIA	100	0.00
89	2	ARBUTUS	70	0.00
90	1	WEIGELA	67	0.00
91	0	ATHYRIUM	60	0.00
92	0	SPIRAEA	52	0.00
93	0	EUONYMUS	51	0.00
94	0	PHOTINIA	51	0.00
95	1	HEMEROCALLIS	45	0.00
96	0	FORSYTHIA	44	0.00
97	0	RUDBECKIA	33	0.00
98	0	MAHONIA	27	0.00
99	0	HOSTA	25	0.0000
100	0	FRAXINUS	24	0.0000
102	1	RHODENDRON	23	0.0000
104	1	CANNA	21	0.0000
105	1	ASTILBE	20	0.0000
106	1	CYRTOMIUM	20	0.0000
107	0	PHILADELPHUS	20	0.0000
108	1	GARDENIA	19	0.0000
109	1	NOT	18	0.0000
110	0	OLEACEAE	18	0.0000
111	0	SALVIA	18	0.0000
112	1	CLIVIA	17	0.0000
113	0	GAURA	16	0.0000
114	0	CARPINUS	14	0.0000
115	1	BERBERIS	13	0.0000
116	0	CLETHRA	13	0.0000
117	0	PEROVSKIA	13	0.0000
118	1	SEQUOIA	12	0.0000
119	0	ABELIA	11	0.0000
120	2	MALUS	11	0.0000
121	1	OCOTEA	11	0.0000
122	0	GENERAL	10	0.0000
123	0	BUDDLEIA	9	0.0000

No.	No. of Species	Host Names	Plants Inspected	% of Total
124	1	CATHARANTHUS	9	0.0000
125	0	COTONEASTER	9	0.0000
126	0	PULMONARIA	9	0.0000
127	0	BOUGAINVILLEA	7	0.00
128	2	PYRUS	7	0.00
129	0	SCABIOSA	7	0.00
130	0	ARACHNOIDES	6	0.00
131	1	CLEYERA	6	0.00
132	1	HEUCHERA	6	0.00
133	1	ITEA	6	0.00
134	1	PARROTIA	6	0.00
135	2	OSMANTHUS	5	0.00
136	1	DRYOPTERIS	5	0.00
137	0	SEDUM	5	0.00
138	1	TERNSTROEMIA	5	0.00
139	0	FICUS	3	0.00
140	1	GAULTHERIA	3	0.00
141	1	LAURUS	3	0.00
142	1	SORBUS	3	0.00
143	1	AUCUBA	2	0.00
144	0	BETULA	2	0.00
145	0	ELAEAGNUS	2	0.00
146	0	LILIUM	2	0.00
147	1	LUDOVIA	2	0.00
148	1	MICHELIA	2	0.00
149	1	AKEBIA	1	0.00
150	1	CALLICARPA	1	0.00
151	1	CALLUNA	1	0.00
152	0	CARAGANA	1	0.00
153	1	CITRUS	1	0.00
154	1	CORYLOPSIS	1	0.00
155	0	CUPRESSUS	1	0.00
156	0	DEUTZIA	1	0.0000
157	0	ERICA	1	0.0000
158	1	HEDERA	1	0.0000
159	1	JUGLANS	1	0.0000
160	1	METASEQUOIA	1	0.0000
161	1	NERIUM	1	0.0000
162	1	OSTRYA	1	0.0000
163	1	OXYDENDRUM	1	0.0000
164	1	PHELLODENDRON	1	0.0000
165	3	PYRUS	1	0.0000
166	0	SARCOCOCCA	1	0.0000
167	1	SEQUOIADENDRON	1	0.0000
168	1	SEVERINIA	1	0.0000
169	1	VITIS	1	0.0000
170	1	X	1	0.0000
			44,657	